Enhancement of laser-based ultrasonic wave detection through signal processing techniques

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Laser generation and detection of ultrasonic signals is a technology that expands the applications for ultrasonic nondestructive evaluation. It is a remote, non contacting method of generating and detecting acoustic energy in materials. Laser-based ultrasonics has been shown to have less sensitivity than traditional ultrasonic testing because the amount of optical energy that can be introduced to a material to generate ultrasonic waves nondestructively is limited by the ablation threshold of the material. In addition, detection sensitivity is limited by the surface conditions of the material as well as the feasible power of the laser used in the interferometer.

To increase the signal-to-noise ratio of laser-based acoustic detection, beam-forming techniques were applied to modeled and measured data. A thermo-acoustic wave propagation model of laser generation and detection was used to simulate data from a bistatic array. The corresponding measured bistatic data set was beam-formed in the same manner as the simulated data. Filters derived by matching measured and modeled beam-formed data were applied to other measured data sets with good results. These filters can be used to enhance images generated from bistatic laser-based ultrasonic data.

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